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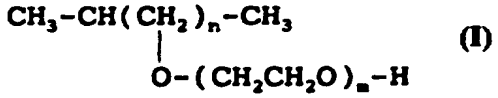
(54) Title: METHOD OF ENHANCING THE GROWTH OF PLANTS

(57) Abstract



(I)

This invention is a method of enhancing the growth of plants. The method comprises applying a nonionic surfactant and, more particularly, an alkyoxypolyethyleneoxyethanol to the soil to protect the seeds and enhance their germination, and to enhance the growth of the plants. The nonionic surfactant is represented by formula (I) wherein n is from 9-15 and m is from 3-40. The nonionic surfactant can be combined with a substantially reduced rate of conventionally used pesticides.

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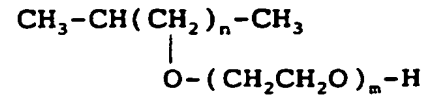
METHOD OF ENHANCING THE GROWTH OF PLANTS

Technical Field

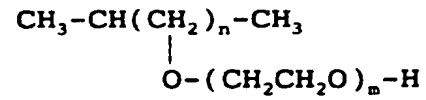
This invention is a method of enhancing the growth of plants comprising applying a nonionic surfactant and, more particularly, an alkyoxypolyethyleneoxyethanol to soil to protect the plant seeds and enhance their germination, and to enhance the subsequent growth of the plants. The nonionic surfactant is represented by the formula:



wherein n is from 9-15 and m is from 3-40.

Background Art

In U.S. Patent No. 5,026,734 to Browning, the present inventor, discloses a method of controlling fungus, mites, termites, and other insect pests. In the disclosed method, a composition comprising a liquid carrier and at least one nonionic surfactant represented by the formula:



wherein n is from 9-15 and m is from 3-40 (hereinafter referred to as "the nonionic surfactant"), are applied to an infested location. The nonionic surfactant is the active ingredient of the applied composition. Browning discloses that this particular surfactant effectively control insect pests, and also provides substantial environmental benefits over the known pesticides which have been found to include toxic pollutants that are injurious to plants, animals and, thus, the ecological balance. In

contrast, the nonionic surfactant is biodegradable. Consequently, unlike the prior used pesticides, the nonionic surfactant can be safely applied without any subsequent monitoring to insure that it does not cause damaging effects.

U.S. Patent, No. 5,143,939 also to Browning, discloses a method of treating soil and agricultural crops to control worms and nematodes. The method comprises applying the nonionic surfactant as the active ingredient to the infested soil and agricultural crops.

Finally, U.S. Patent, No. 5,141,963 to Browning, discloses a method of controlling ticks, mosquitoes and other insect pests by applying the nonionic surfactant as the active ingredient to an infested area.

The above mentioned patents have demonstrated that a particular nonionic surfactant can be used to effectively control a wide variety of insect pests when applied to infested soils and plants such as agricultural crops. These patents have further demonstrated that the nonionic surfactant can be applied to plants and soil without harming the plants, humans and other animals, or producing any adverse environmental effects.

The prior art has not recognized, however, that in addition to the nonionic surfactant being an extremely effective insecticide that is essentially harmless to plants, animals and the environment, the nonionic surfactant actually enhances the growth of plants.

The prior art further has not recognized that the

nonionic surfactant can be used in combination with a significantly reduced rate of conventional pesticides to increase their plant growth enhancing effectiveness. Accordingly, the prior art has also failed to recognize that the known nonionic surfactant can substantially increase the cost effectiveness of the expensive conventional pesticides which can then be applied at a substantially reduced rate. Furthermore, by combining the environmentally harmful conventional pesticides at a reduced rate with the nonionic surfactant, the resulting toxicity of the compositions can be substantially reduced.

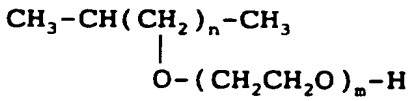
DISCLOSURE OF THE INVENTION

The present invention has been made in view of the above inadequacies of the prior art and has as an object to provide a method of enhancing the growth of plants by applying to the soil a chemical that is essentially harmless to the plants when applied at proper rates, as well as to humans and other animals.

It is another object of the present invention to provide a method of enhancing the growth of plants by applying to the soil a chemical that is essentially harmless to the plants, in combination with a reduced rate of conventional pesticides, to produce compositions having increased growth enhancing properties and reduced toxicity.

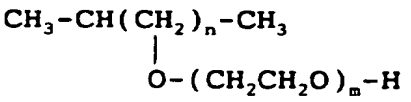
A method of enhancing the growth of plants is disclosed, which comprises applying to the soil an

effective amount of a composition to enhance plant growth. The composition consists essentially of a liquid carrier and at least one nonionic surfactant represented by the formula:



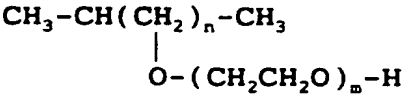
wherein n is from 9-15 and m is from 3-40

A method of enhancing the germination of plant seeds is also disclosed, which comprises applying to the soil in which the seeds are planted an effective amount of a composition to enhance seed germination. The composition consists essentially of a liquid carrier and at least one nonionic surfactant represented by the formula:



wherein n is from 9-15 and m is from 3-40.

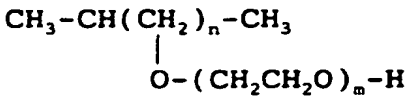
A method of enhancing the growth of plants is also disclosed, which comprises applying to the soil a composition comprised of a liquid carrier and at least one plant growth enhancing agent represented by the formula:



wherein n is from 9-15 and m is from 3-40. The at least one plant growth enhancing agent is present in the composition in an effective amount to enhance plant growth.

Finally, a method of enhancing the germination of plant seeds is disclosed, which comprises applying to the

soil in which the seeds are planted a composition comprising a liquid carrier and at least one plant seed germination enhancing agent represented by the formula:

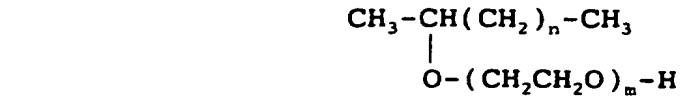


wherein n is from 9-15 and m is from 3-40. The at least one plant seed germination enhancing agent is present in the composition in an effective amount to enhance seed germination.

BEST MODE FOR CARRYING OUT THE INVENTION

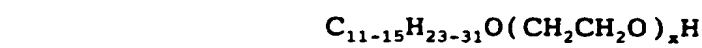
The above-mentioned alkyloxypolyethyleneoxyethanols are biodegradable nonionic surfactants consisting of a mixture of ethoxylates of secondary alcohols having from 9 to 15 carbon atoms in the aliphatic hydrophobic chain, and which have an average of 3 to 5, 7, 9, 12, 15, 20, 30 or 40 moles of ethylene oxide, respectively, in the hydrophilic entity. Materials having these compositions are available commercially as the TERGITOL 15-S series (i.e., 15-S-3, 15-S-5, 15-S-7, 15-S-9, 15-S-12, and 15-S-15) of ethylene oxide derivatives manufactured by the Union Carbide Corporation. One method for the manufacture of such nonionic surface active agents is believed to be disclosed in U.S. Patent No. 2,870,220. A blend or combination of these secondary alcohol ethoxylates such as TERGITOL 15-S-3 added to TERGITOL 15-S-9 are clear, easily handled materials for application. Of the available ethoxylates of secondary alcohols, TERGITOL 15-S-9 is preferred. As

explained above, these nonionic surfactants can be represented by the formula:



wherein n is form 9 to 15 and m is from 3 to 40.

Union Carbide characterizes the TERGITOL series with the empirical formula:



in its Material Safety Data Sheets.

The nonionic surfactants can be applied to targets such as seeds, plants, soils, and the like, at a technical strength. Because of the active nature of the secondary alcohol ethoxylates, however, they are preferably admixed with a suitable carrier, especially when applied to targets such to plants, seeds and foliage. Preferred inexpensive carriers are water or vegetable oil. The TERGITOL series are water soluble. Other more expensive carriers may optionally be used. The nonionic surfactants are preferably applied in an amount of about 8 oz. to about 32 oz. per acre. The corresponding amount of water or vegetable oil used as the carrier can vary considerably, as long as a preferred amount of the nonionic surfactant is applied to the plants. Because vegetable oil forms a much finer mist than water, a substantially reduced volume of oil can be used with the nonionic surfactant as compared to the same amount of the nonionic surfactant in water.

In recent laboratory testing, it has been unexpectedly discover d that TERGITOL 15-S-9 provides a number of

previously unrecognized advantages. It has been determined that when TERGITOL 15-S-9 is applied to soil, it protects plant seeds and enhances their germination. It is believed that this effect occurs because when it contacts the seeds, TERGITOL 15-S-9 forms a relatively fast drying seed covering that reduces the density of disease causing pathogens in the surrounding soil. Consequently, the germination seed experiences an early growth, and the plant stand and plant growth are improved.

After germination, plants that have been treated with TERGITOL 15-S-9 have had improved root systems in terms of their length and weight, improved shoot weight and plant height, and improved stand.

It has also been determined in laboratory testing that TERGITOL 15-S-9 may be combined with conventional pesticides to improve the effectiveness of the conventional pesticides. By combining reduced rates of conventional pesticides with a relatively smaller amount of TERGITOL, the effectiveness of the conventional pesticides are improved even when used at substantially less than the manufacturers' recommended rates.

The following examples are presented for the purpose of further illustrating the principles and previously unrecognized advantages of the present invention, and are not to be considered as limiting.

SEED PROTECTANT/GERMINATION ENHANCER

TERGITOL 15-S-9 was applied directly to cotton seed in

the furrow at planting. The following germination and plant stand count data were measured.

Germination Results

TERGITOL 15-S-9 Applied (pints)	Plants/10 seeds
0	9
1	9.6
2	9.2
3	9.2

Plant Stand Counts

TERGITOL 15-S-9 Applied (pints)	Plants/Plot
0	126.6
1	158.6

The above data clearly demonstrate the advantage of applying TERGITOL 15-S-9 to the soil to enhance the germination of plant seeds, and to improve the plant stand.

PLANT GROWTH ENHANCER

TERGITOL 15-S-9 was added directly to the soil to demonstrate its effect on the enhanced growth of cotton seedlings in controlled greenhouse conditions. In the laboratory testing, DPL-20 cotton was used as the cultivar. The experimental design was a randomized complete block with four replications, and the plot design was two-pint styrofoam cups containing one seed each. For the chemical treatments, a control using water, and two different compositions containing 1 pint/acre and 2 pints/acre of TERGITOL 15-S-9 in water, were used.

The soil used in the laboratory testing was steriliz d

TABLE 1

EFFECT OF SM-9 ON COTTON SEEDLING PLANT GROWTH IN THE GREENHOUSE

Treatment	Rate (pint/acre)	Root Length (cm)	Root Weight (gm) Fresh	Root Weight (gm) Dry
Five Days After Planting				
1. Control	---	1.275 b	0.030 b	0.003 b
2. TERGITOL 15-S-9	1	5.250 a	0.125 a	0.014 a
3. TERGITOL 15-S-9	2	5.075 a	0.147 a	0.015 a
LSD = 0.05		2.024	0.056	0.011
Six Days After Planting				
1. Control	---	3.100 a	0.096 b	0.017 a
2. TERGITOL 15-S-9	1	5.975 a	0.121 b	0.021 a
3. TERGITOL 15-S-9	2	6.200 b	0.164 a	0.019 a
LSD = 0.05		2.169	0.039	0.020

Ten Days After Planting				
1. Control	---	3.425 b	0.082 b	0.028 a
2. TERGITOL 15-S-9	1	8.457 a	0.177 a	0.021 a
3. TERGITOL 15-S-9	2	5.356 a	0.179 a	0.028 a
LSD = 0.05		2.823	0.082	0.033
Eleven Days After Planting				
1. Control	---	4.455 b	0.074 b	0.013 a
2. TERGITOL 15-S-9	1	7.500 ab	0.141 ab	0.022 a
3. TERGITOL 15-S-9	2	8.375 a	0.192 a	0.024 a
LSD = 0.05		2.956	0.073	0.013
Eighteen Days After Planting				
1. Control	---	5.700 a	0.236 a	0.054 a
2. TERGITOL 15-S-9	1	7.500 a	0.396 a	0.115 a
3. TERGITOL 15-S-9	2	7.550 a	0.304 a	0.052 a
LSD = 0.05		2.206	0.268	0.122

potting soil. By using this soil, the potential result modifying factors of insect pests, nematodes and plant diseases were eliminated. Accordingly, the test results were attributed with greater confidence to the effect of TERGITOL 15-S-9 on the growth of the cotton seedlings.

Moreover, by using sterilized soil, the test results could not be attributed solely to TERGITOL 15-S-9 destroying insect pests, nematodes and plant diseases caused by pathogens such as fungi, as this chemical is capable of doing.

All of the treatments were subsequently examined with respect to phytotoxicity and plant stand, and the plant growth related parameters of fresh and dry root weights and shoot weights, root lengths and plant heights were measured and recorded. The experimental results having a 95% confidence level are shown in TABLE 1.

In TABLES 1 and 2, the reported data are the mean values of the four replications. The means were compared using Fisher's protected least significant difference (LSD) test.

TABLE 1

EFFECT OF SM-9 ON COTTON SEEDLING PLANT GROWTH IN THE GREENHOUSE

Treatment	Rate (pint/acre)	Root Length (cm)	Root Weight (gm) Fresh	Dry
Five Days After Planting				
1. Control	---	1.275 b	0.030 b	0.003 b
2. TERGITOL 15-S-9	1	5.250 a	0.125 a	0.014 a
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LSD = 0.05		2.024	0.056	0.011
Six Days After Planting				
1. Control	---	3.100 a	0.096 b	0.017 a
2. TERGITOL 15-S-9	1	5.975 a	0.121 b	0.021 a
3. TERGITOL 15-S-9	2	6.200 b	0.164 a	0.019 a
LSD = 0.05		2.169	0.039	0.020

Seven Days After Planting				
1. Control	---	3.925 b	0.096 b	0.014 a
2. TERGITOL 15-S-9	1	7.100 a	0.123 a	0.018 a
3. TERGITOL 15-S-9	2	7.900 a	0.137 a	0.026 a
LSD = 0.05		3.399	0.070	0.020
Eight Days After Planting				
1. Control	---	3.350 b	0.065 b	0.012 a
2. TERGITOL 15-S-9	1	7.300 a	0.163 ab	0.014 a
3. TERGITOL 15-S-9	2	7.100 a	0.224 a	0.016 a
LSD = 0.05		2.170	0.126	0.009
Nine Days After Planting				
1. Control	---	3.750 b	0.067 a	0.008 a
2. TERGITOL 15-S-9	1	5.225 a	0.094 a	0.016 a
3. TERGITOL 15-S-9	2	6.550 a	0.184 a	0.016 a
LSD = 0.05		5.447	0.137	0.015

Ten Days After Planting				
1. Control	---	3.425 b	0.082 b	0.028 a
2. TERGITOL 15-S-9	1	8.457 a	0.177 a	0.021 a
3. TERGITOL 15-S-9	2	5.356 a	0.179 a	0.028 a
LSD = 0.05		2.823	0.082	0.033
Eleven Days After Planting				
1. Control	---	4.455 b	0.074 b	0.013 a
2. TERGITOL 15-S-9	1	7.500 ab	0.141 ab	0.022 a
3. TERGITOL 15-S-9	2	8.375 a	0.192 a	0.024 a
LSD = 0.05		2.956	0.073	0.013
Eighteen Days After Planting				
1. Control	---	5.700 a	0.236 a	0.054 a
2. TERGITOL 15-S-9	1	7.500 a	0.396 a	0.115 a
3. TERGITOL 15-S-9	2	7.550 a	0.304 a	0.052 a
LSD = 0.05		2.206	0.268	0.122

		Twenty-five Days After Planting		
1. Control---		16.850 b	1.145 a	0.165 b
2. TERGITOL 15-S-9	1	23.425 a	1.455 a	0.228 a
3. TERGITOL 15-S-9	2	17.950 ab	1.433 a	0.108 ab
LSD = 0.05		6.396	0.576	0.118

As demonstrated by the laboratory data, for each period of time, SM-9 significantly enhanced the growth of the cotton plants as compared to the untreated control. For each of the groups of data representing a different time period, the root length and the root weight (fresh and dry) were greater for the treated plants as compared to the controls. This result was demonstrated for treatments with one and two pints per acre rates of TERGITOL 15-S-9.

It is believed by the present inventor that the growth enhancing effect of TERGITOL 15-S-9 is caused by two different, but related, mechanisms. These mechanisms are that TERGITOL 15-S-9 increases: (1) the uptake of water by the plant, and (2) the absorption of nutrients from the soil into the plant. Because the nutrients are transported into the plant along with the water, when nutrients are present in the soil, the two mechanisms combine to provide a greatly improved intake of nutrients into the plant.

As shown by the data, TERGITOL 15-S-9 causes the plants to grow faster. When pathogens are present in the soil, TERGITOL 15-S-9 destroys them at the critical early growth stage so that the plants can experience a better early growth. By increasing the frequency of plants surviving this critical early stage, TERGITOL 15-S-9 can directly increase plant stand.

The data also demonstrate that early plant growth can

be greatly improved in the absence of pathogens. More particularly, the data for five days after planting indicate that the root length and the root weight were significantly greater for the seedlings treated with TERGITOL 15-S-9 as compared to the control. These data are believed to be due to an increased uptake of water by the treated plants.

To demonstrate that the growth enhancing effect of TERGITOL 15-S-9 is not limited to cotton plants, it was also added directly to sterilized soil containing COKER-156 soybeans in laboratory testing. The experimental design was a randomized complete block with four replications, and the plot design was two-pint styrofoam cups containing one seed each. For the chemical treatments, a control using water, and two different compositions containing 1 pint/acre and 2 pints/acre of TERGITOL 15-S-9 in water, were used.

All treatments were subsequently examined with respect to phytotoxicity and plant stand, and the plant growth related parameters of fresh and dry root weights and shoot weights, root lengths, and plant heights were measured and recorded. The experimental results having a 95% confidence level are shown in TABLE 2.

TABLE 2

EFFECT OF SM-9 ON SOYBEAN SEEDLING PLANT GROWTH IN THE GREENHOUSE

Treatment	Rate (pint/acre)	Root Length (cm)	Root Weight (gm) Fresh	Dry
Five Days After Planting				
1. Control	---	4.947 a	0.172 a	0.045 a
2. TERGITOL 15-S-9	1	5.777 a	0.201 a	0.041 a
3. TERGITOL 15-S-9	2	7.500 a	0.188 a	0.050 a
LSD = 0.05		5.037	0.087	0.029
Six Days After Planting				
1. Control	---	8.368 a	0.343 a	0.108 a
2. TERGITOL 15-S-9	1	9.150 a	0.371 a	0.116 a
3. TERGITOL 15-S-9	2	11.075 b	0.376 a	0.128 a
LSD = 0.05		5.585	0.151	0.066

Seven Days After Planting				
1. Control	---	8.350 a	0.297 a	0.083 a
2. TERGITOL 15-S-9	1	9.975 a	0.696 ab	0.248 a
3. TERGITOL 15-S-9	2	11.750 a	1.065 b	0.486 a
LSD = 0.05		4.855	0.439	0.209
Nine Days After Planting				
1. Control	---	10.650 a	0.773 a	0.330 a
2. TERGITOL 15-S-9	1	12.525 a	1.159 a	0.567 a
3. TERGITOL 15-S-9	2	12.650 a	1.076 a	0.498 a
LSD = 0.05		4.415	0.536	0.346
Eleven Days After Planting				
1. Control	---	12.900 a	1.527 a	0.595 a
2. TERGITOL 15-S-9	1	12.500 a	1.909 a	0.383 a
3. TERGITOL 15-S-9	2	14.325 a	2.029 a	0.524 a
LSD = 0.05		3.496	0.799	0.263

		Eighteen Days After Planting		
1. Control	---	9.450 a	3.553 a	0.763 a
2. TERGITOL 15-S-9	1	10.805 a	4.395 a	1.008 a
3. TERGITOL 15-S-9	2	11.850 a	4.026 a	1.158 a
LSD = 0.05		4.682	1.086	0.263

The data in TABLE 2 demonstrate that TERGITOL 15-S-9 enhances the growth of soybean plants.

COMPOSITIONS OF TERGITOL AND CONVENTIONAL PESTICIDES

Finally, tests were conducted to demonstrate that TERGITOL 15-S-9 can be combined with conventional pesticides to increase their effectiveness, and also reduce the amount thereof that need be applied. Relatively smaller amounts of TERGITOL 15-S-9 were added to a number of conventional pesticides, and the resulting compositions were applied to cotton seedlings. As a comparison, the full rates (i.e., the manufacturers' recommended rates) of the conventional pesticides were also applied to the soil. The subsequent growth of the plants in terms of the cotton stand, cotton height and cotton yield were later measured and recorded. The results are shown in TABLE 3.

TABLE 3

Cotton Stand

Treatment/Rate	No. Cotton Plants/Plot
1. TERRACHLOR SUPER X (full rate)	124.4
2. TERRACHLOR SUPER X (1/2 rate) plus TERGITOL 15-S-9 (1 pint)	127.6
3. RIDOMIL (full rate)	125.2
4. RIDOMIL (1/2 rate) plus TERGITOL 15-S-9 (1 pint)	129.2

Cotton Height

Treatment/Rate	Cotton Height (in.)
1. TEMIK (7 lbs.)	42.88
2. TEMIK (3.5 lbs.) plus TERGITOL 15-S-9 (1 pint)	44.56
3. TERRACHLOR SUPER X (full rate)	48.15
4. TERRACHLOR SUPER X (1/2 rate) plus TERGITOL 15-S-9 (1 pint)	48.34
5. RIDOMIL (full rate)	46.16
6. RIDOMIL (1/2 rate) plus TERGITOL 15-S-9 (1 pint)	45.96

Cotton Yield

Treatment/Rate	Cotton Yield (lbs.)
1. TERRACHLOR SUPER X (full rate)	2914.13
2. TERRACHLOR SUPER X (1/2 rate) plus TERGITOL 15-S-9 (1 pint)	2962.20
3. RIDOMIL (full rate)	2191.72
4. RIDOMIL (1/2 rate) plus TERGITOL 15-S-9 (1 pint)	2643.67

The data in TABLE 3 clearly demonstrate the previously unrecognized advantage of TERGITOL 15-S-9 as an additive to known pesticides to improve their effectiveness. For each different known pesticide and growth parameter, except for RIDOMIL and cotton height, the compositions containing a one-half rate of the pesticide plus one pint of TERGITOL 15-S-9 produced better results than the pesticides applied at a full rate. Furthermore, although not directly measured in the tests, the toxicity of the compositions would have been reduced as compared to the full rates of the pesticides, because reduced volumes of pesticides were applied.

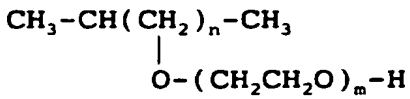
INDUSTRIAL APPLICABILITY

The present invention has industrial applicability as a method of enhancing the growth of various types of plants in the soil. The plants may be, for example, soybeans and

cotton. The present invention further has industrial applicability as a method of enhancing the germination of plant seeds in soil. The chemical applied in the present invention is essentially harmless to plants when it is applied at proper rates, as well as to humans and other animals. Further, the chemical can be combined with a reduced rate of conventional pesticides, to produce compositions having increased growth enhancing properties and reduced toxicity.

What is claimed is:

1. A method of enhancing the growth of plants in soil, comprising applying to the soil an effective amount of a composition to enhance plant growth, said composition consisting essentially of at least one nonionic surfactant represented by the formula:



wherein n is from 9-15 and m is from 3-40.

2. The method of Claim 1, wherein said plants are cotton plants.

3. The method of Claim 1, wherein said plants are soybean plants.

4. The method of Claim 1, wherein said liquid carrier is comprised of water.

5. The method of Claim 1, wherein said liquid carrier is comprised of vegetable oil.

6. The method of Claim 1, wherein n is 15 and m is 9.

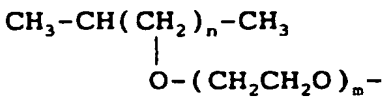
7. The method of Claim 1, wherein said at least one

nonionic surfactant is applied to the soil at a rate of at least one pint/acre.

8. The method of Claim 7, wherein said at least one nonionic surfactant is applied to the soil at a rate of from about 1 pint/acre to about 2 pints/acre.

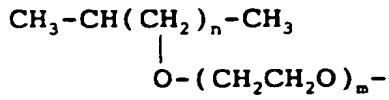
9. The method of Claim 7, wherein n is 15 and m is 9.

10. A method of enhancing the growth of plants in soil, comprising applying to the soil an effective amount of a composition to enhance plant growth, said composition consisting essentially of a liquid carrier and at least one nonionic surfactant represented by the formula:



wherein n is from 9-15 and m is from 3-40, and the nonionic surfactant is applied at a rate of at least approximately 8 ounces/acre.

11. A method of enhancing the germination of plant seeds in soil, comprising applying to the soil in which the seeds are planted an effective amount of a composition to enhance seed germination, said composition consisting essentially of a liquid carrier and at least one nonionic surfactant represented by the formula:



wherein n is from 9-15 and m is from 3-40.

12. The method of Claim 9, wherein said liquid carrier is comprised of water.

13. The method of Claim 9, wherein said liquid carrier is comprised of vegetable oil.

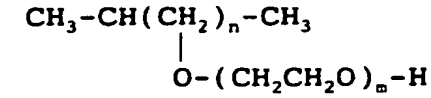
14. The method of Claim 9, wherein n is 15 and m is 9.

15. The method of Claim 9, wherein said at least one nonionic surfactant is applied to the soil at a rate of at least about one pint/acre.

16. The method of Claim 13, wherein said at least one nonionic surfactant is applied to the soil at a rate of between about one pint/acre to two pints/acre.

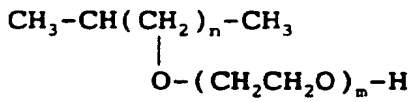
17. The method of Claim 15, wherein n is 15 and m is 9.

18. A method of enhancing the growth of plants in soil, comprising applying to the soil a composition comprised of a liquid carrier and at least one plant growth enhancing agent represented by the formula:



wherein n is from 9-15, m is from 3-40 and said at least one plant growth enhancing agent is present in said composition in an effective amount to enhance plant growth.

19. A method of enhancing the germination of plant seeds in soil, comprising applying to the soil in which the seeds are planted a composition comprised of a liquid carrier and at least one plant seed germination enhancing agent represented by the formula:



wherein n is from 9-15, m is from 3-40 and said at least one plant seed germination enhancing agent is present in said composition in an effective amount to enhance seed germination.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/02115

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A01N 31/02
US CL :504/351

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 504/351, 116

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,096,661 (CLECKNER) 27 June 1978, see claim 7	18, 19
A	US, A, 5,026,734 (BROWNING) 25 June 1991.	1-19
A	US, A, 5,143,939 (BROWNING) 01 SEPTEMBER 1992.	1-19
A	US, A, 5,141,963 (BROWNING) 25 August 1992.	1-19
X, E	US, A, 5,391,542 (BROWNING) 21 February 1995, see entire document.	1-19

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 01 MAY 1995	Date of mailing of the international search report 30 MAY 1995
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